Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

ACTRiS

Mineral dust modelling and ensemble-based data assimilation at the Barcelona Supercomputing Center

Enza Di Tomaso

with inputs from the rest of the BSC Team

BSC Tasks in WP13

- **To establish a delayed and NRT model monitoring/evaluation system using ACTRIS-2** data for the WMO Sand and Dust Storm-Warning and Assessment System (SDS-WAS) models.

→ Multi-Model Activities

- **To investigate the value of assimilating ACTRIS-2 data** in a dust prediction system (NMMB/BSC-CTM) for selected case studies in a regional domain.

→ BSC Dust Model

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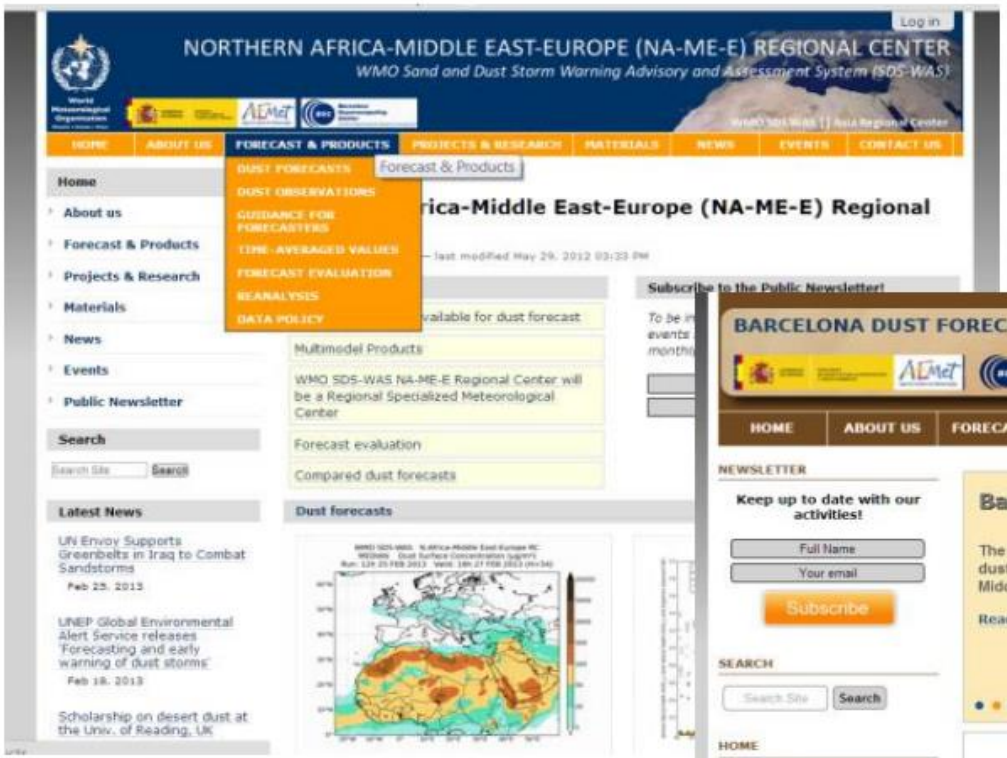
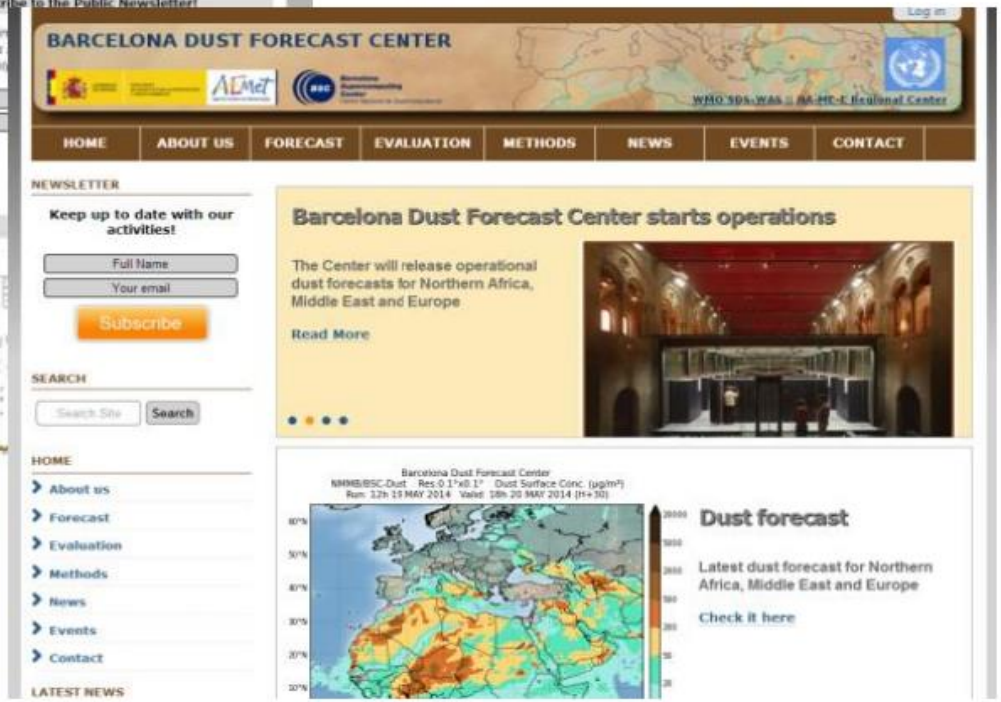
→ BSC Dust Model

We will build on our current capabilities that have been developed so far mainly for column-integrated products

WMO Dust Centres

BSC evaluation activities are carried out under two WMO initiatives





RESEARCH

http://sds-was.aemet.es/

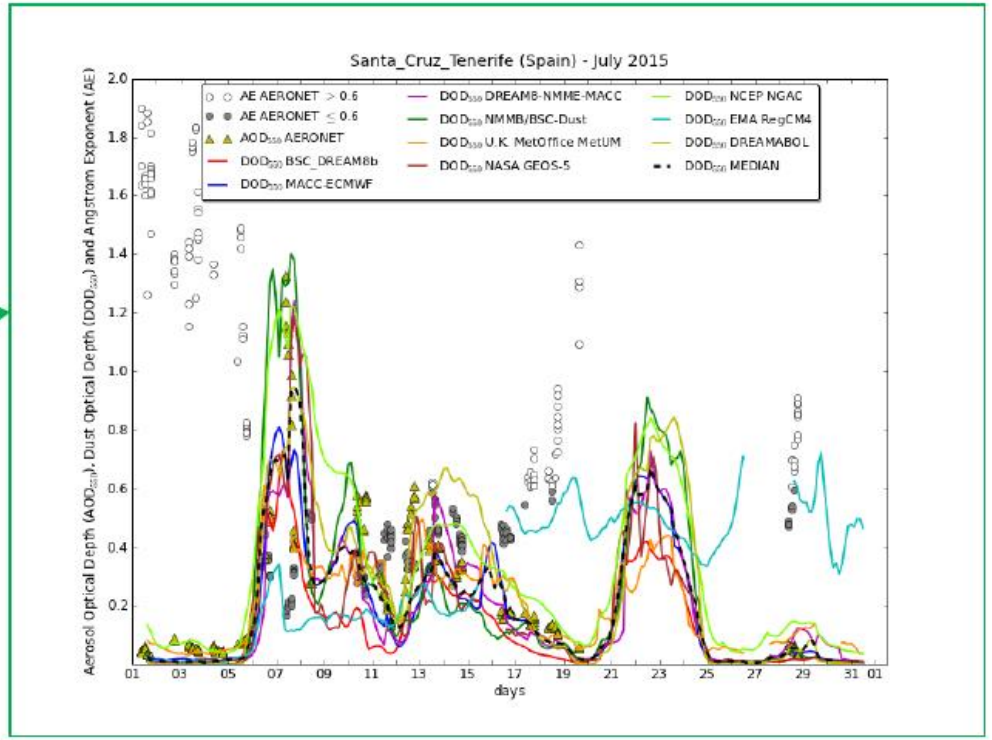
in collaboration with AEMet Agencia Estatal de Meteorología

OPERATIONAL

http://dust.aemet.es/

Slide courtesy of Sara Basart

SDS-WAS: NRT Evaluation using AERONET



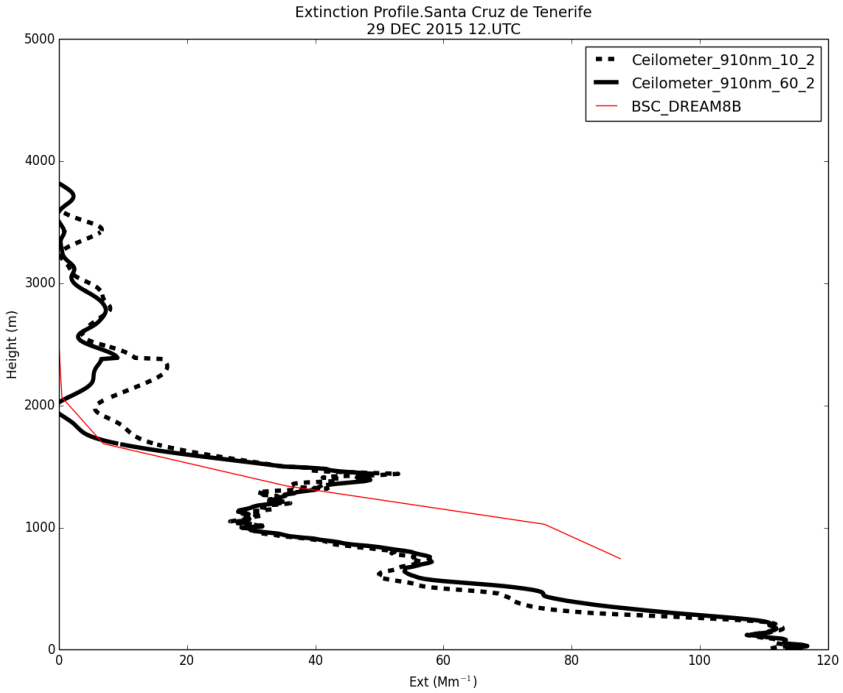
Model evaluation metrics (bias, correlation, RMSE and FGE) are calculated:

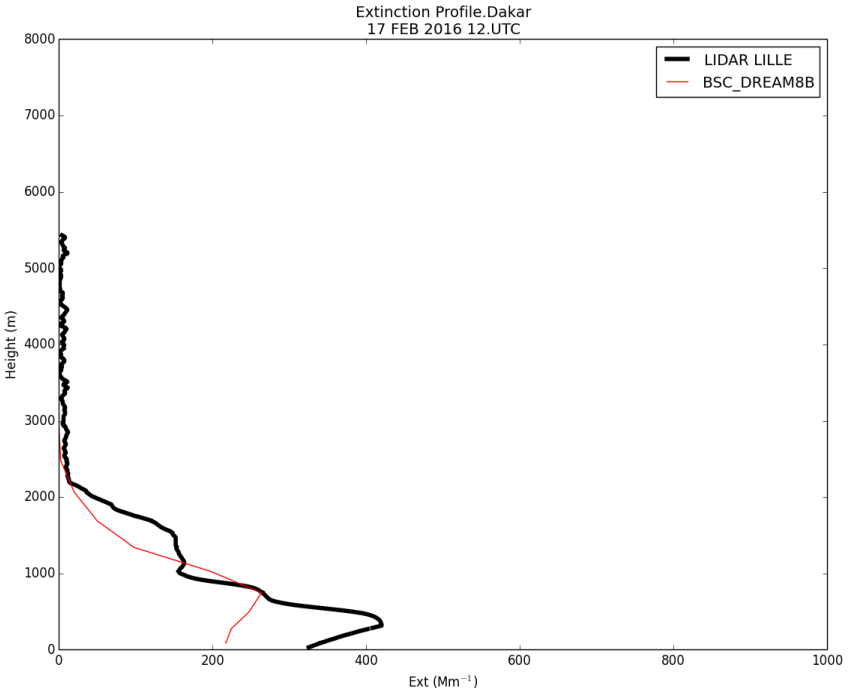
- By regions: NA-ME-E, Sahel/Sahara, Middle East and Mediterranean
- By time periods: monthly, seasonal and annual

NRL evaluation is performed also using not assimilated satellite observations

Slide courtesy of Sara Basart

SDS-WAS: Comparison of Vertical Profiles



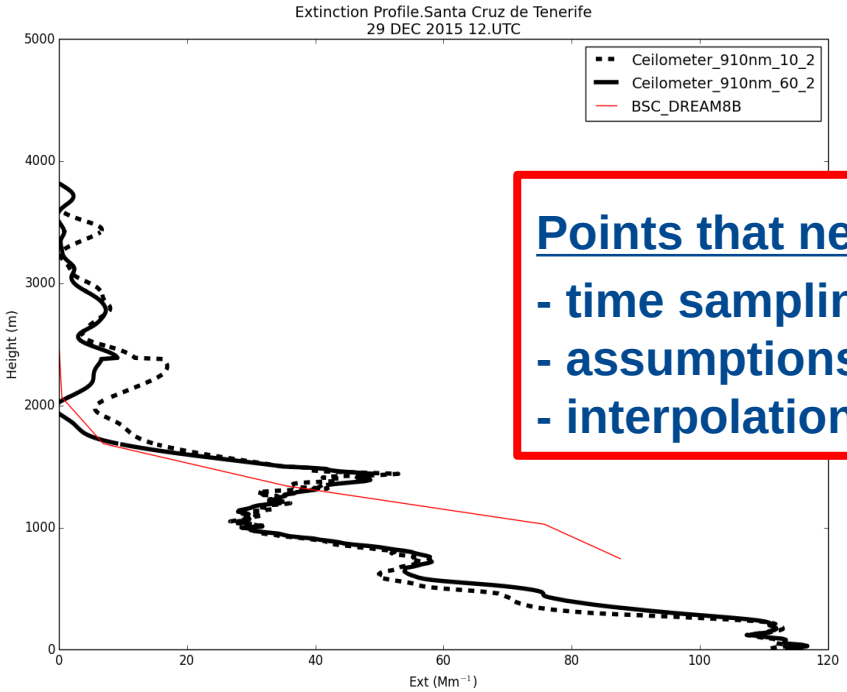


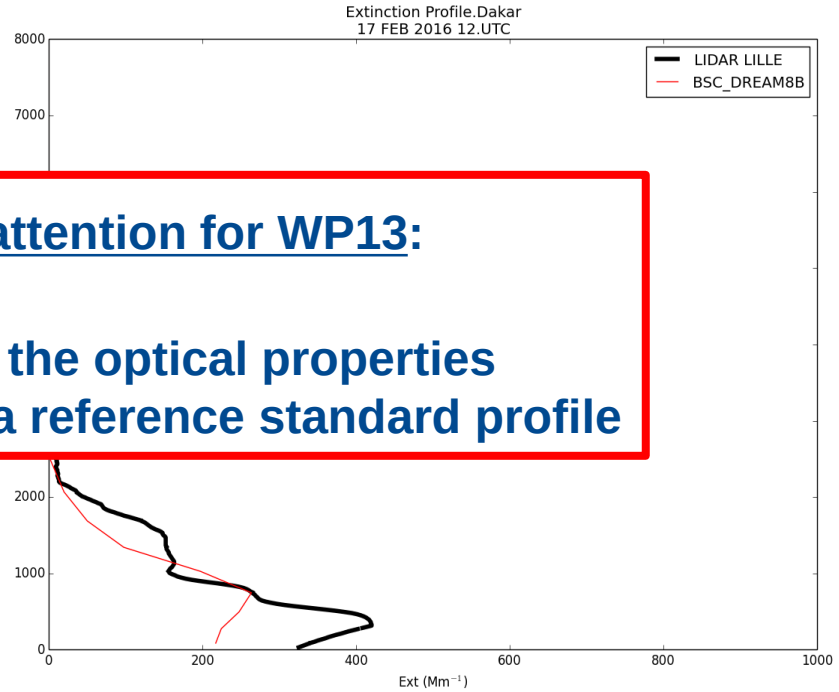
- Daily comparison of extinction vertical profiles involving the BSC-DREAM8b model and the profilers of Santa Cruz de Tenerife (AEMET) and Dakar (Univ. Lille)

- The plan is to extend it to other models and profilers

Slide courtesy of Enric Terradellas

SDS-WAS: Comparison of Vertical Profiles





Points that need attention for WP13:

- time sampling
- assumptions on the optical properties
- interpolation to a reference standard profile

- Daily comparison of extinction vertical profiles involving the BSC-DREAM8b model and the profilers of Santa Cruz de Tenerife (AEMET) and Dakar (Univ. Lille)

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SDS-WAS: Multi-Model Products

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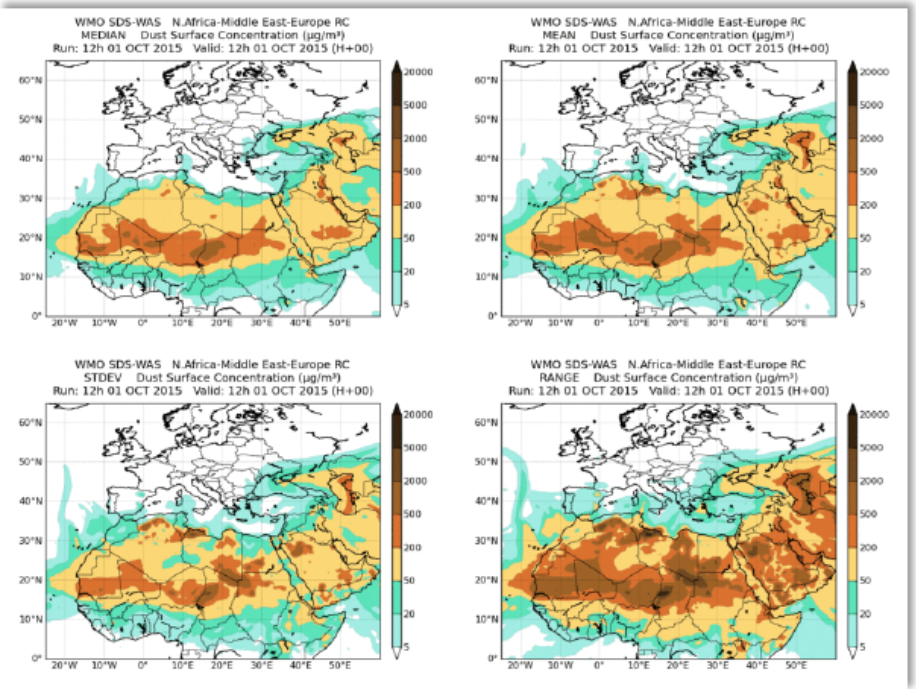
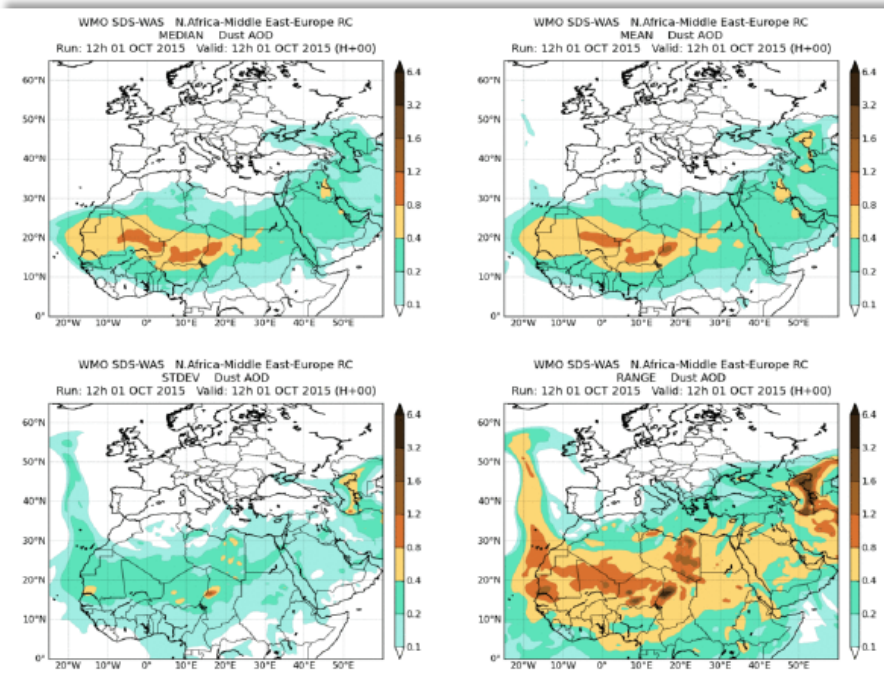
Surface concentration



AOD at 550nm



from 1-Oct-2015 12:00 to 3-Oct-2015 00:00

Model outputs are bi-linearly interpolated to a common 0.5ºx0.5º grid mesh. Then, different multi-model products are generated:

CENTRALITY: median - mean

SPREAD: standard deviation – range of variation

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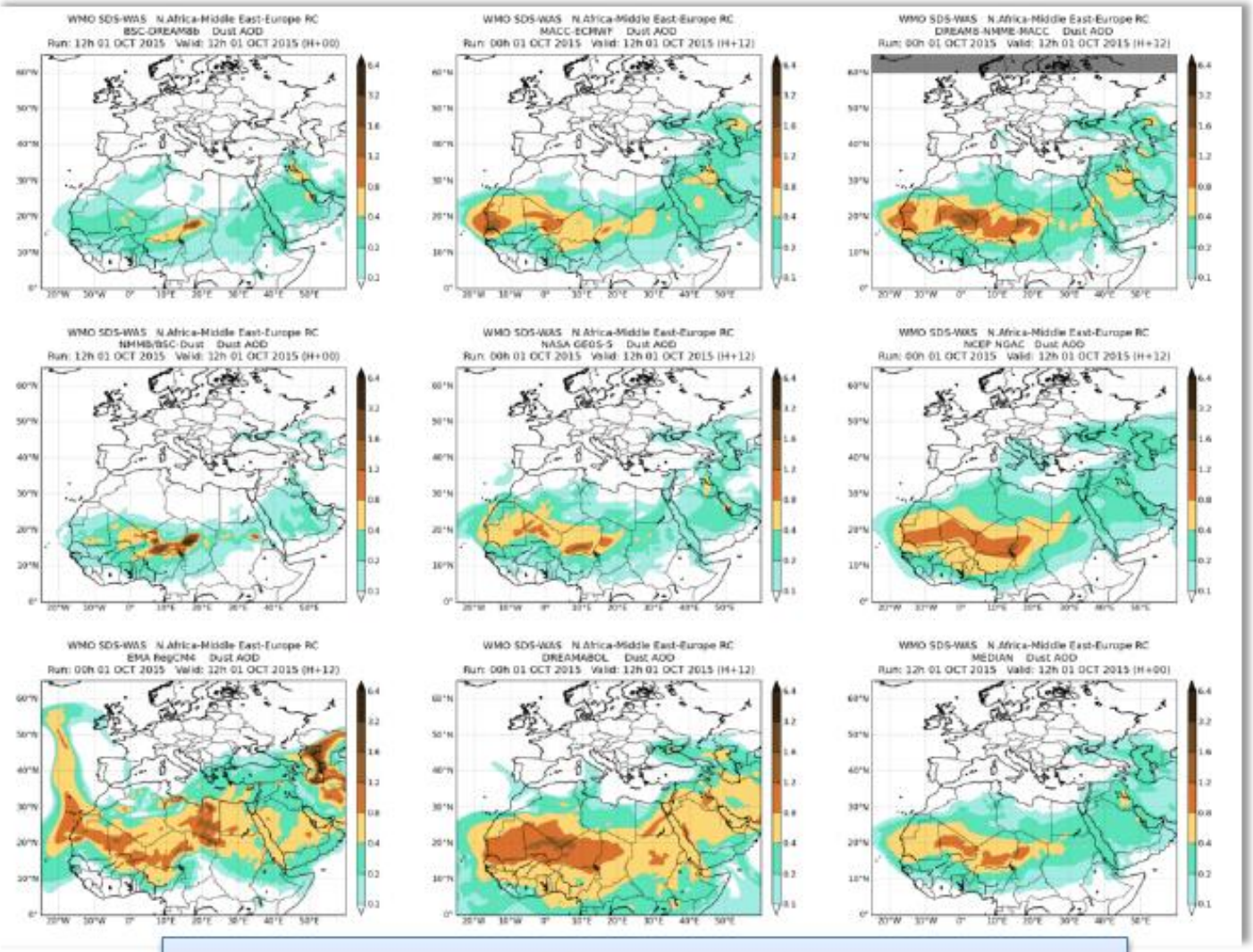
Slide courtesy of Sara Basart

SDS-WAS: Joint Visualisation



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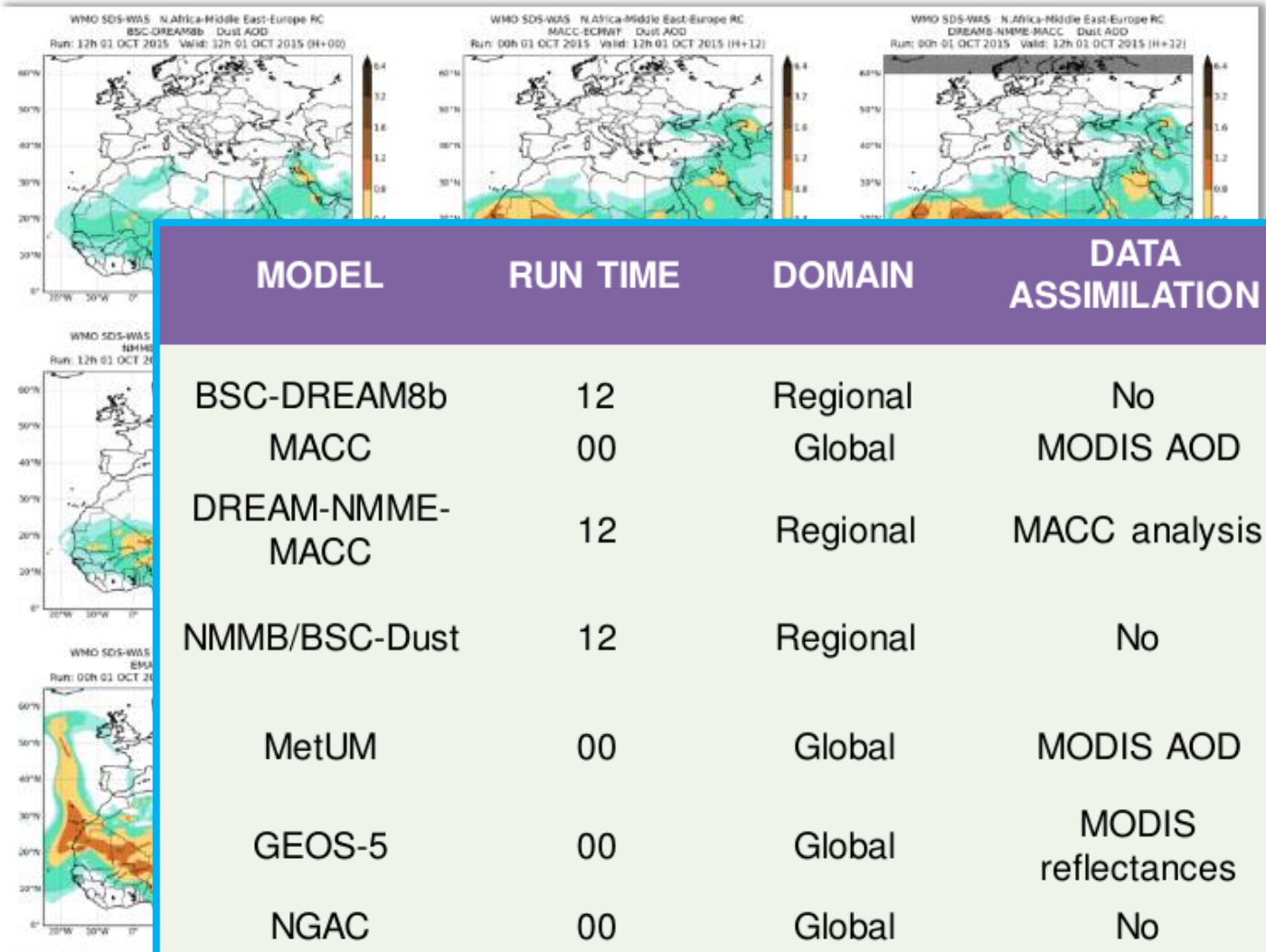

MODEL	RUN TIME	DOMAIN	DATA ASSIMILATION
BSC-DREAM8b	12	Regional	No
MACC	00	Global	MODIS AOD
DREAM-NMME-MACC	12	Regional	MACC analysis
NMMB/BSC-Dust	12	Regional	No
MetUM	00	Global	MODIS AOD
GEOS-5	00	Global	MODIS reflectances
NGAC	00	Global	No
EMA REG CM4	12	Regional	No
DREAMABOL	12	Regional	No

Slide courtesy of Sara Basart

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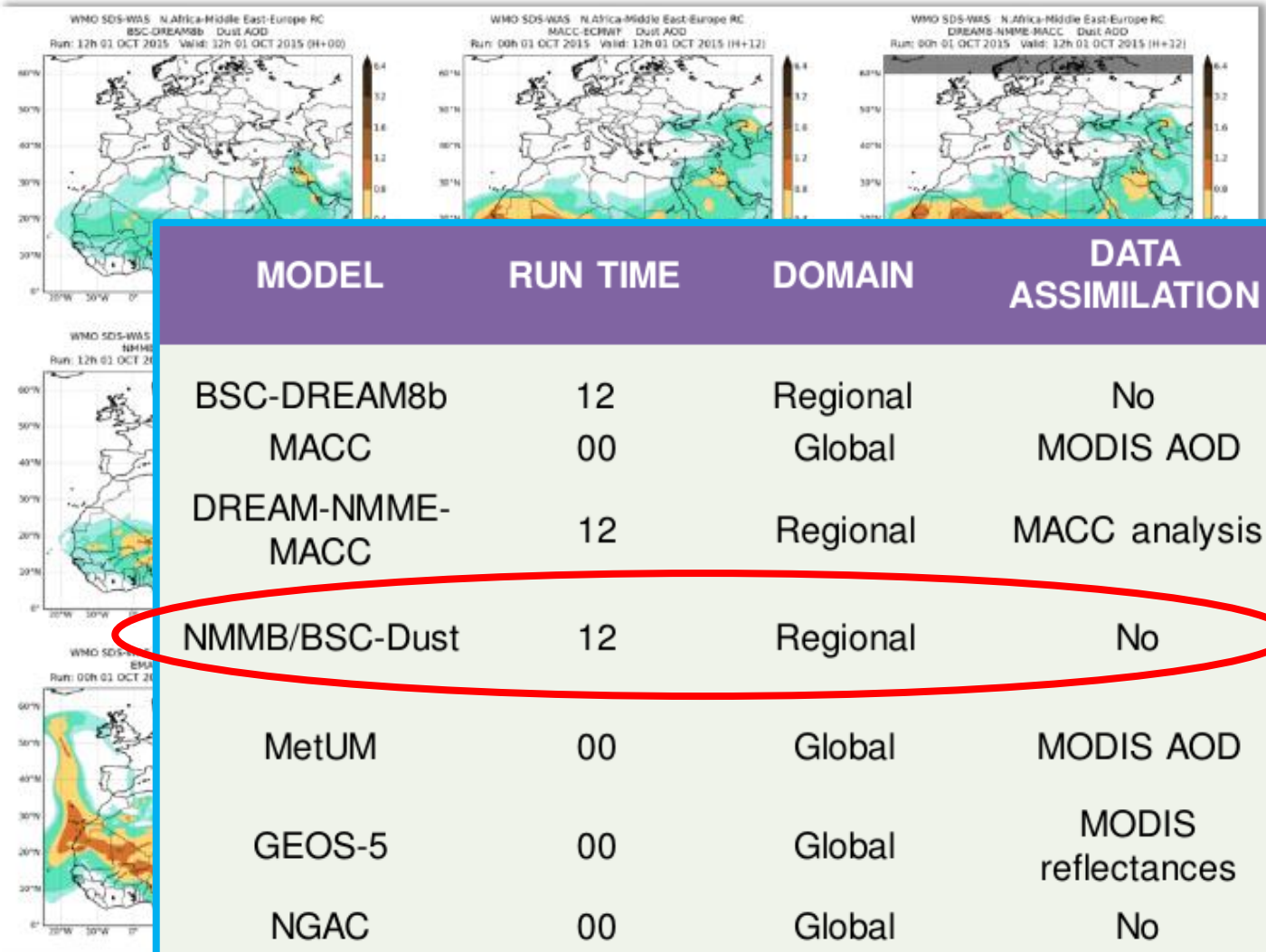

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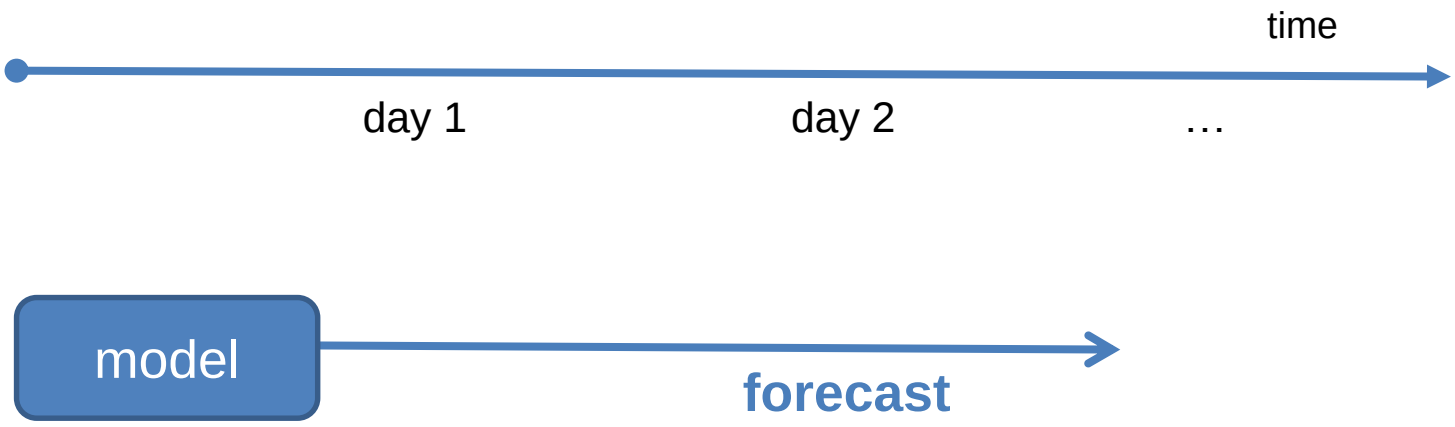
Slide courtesy of Sara Basart

Operation Forecast Flow at BSC



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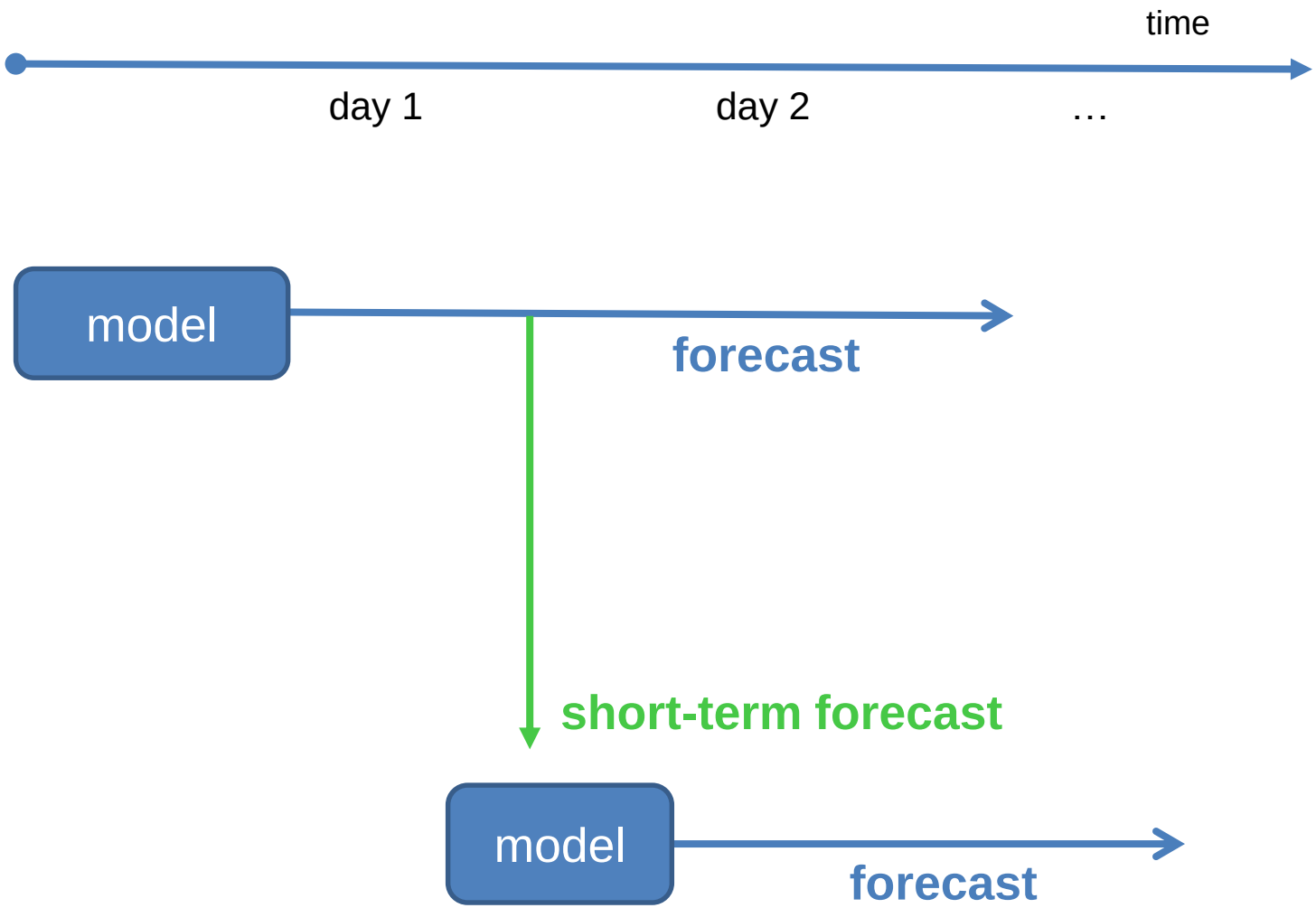
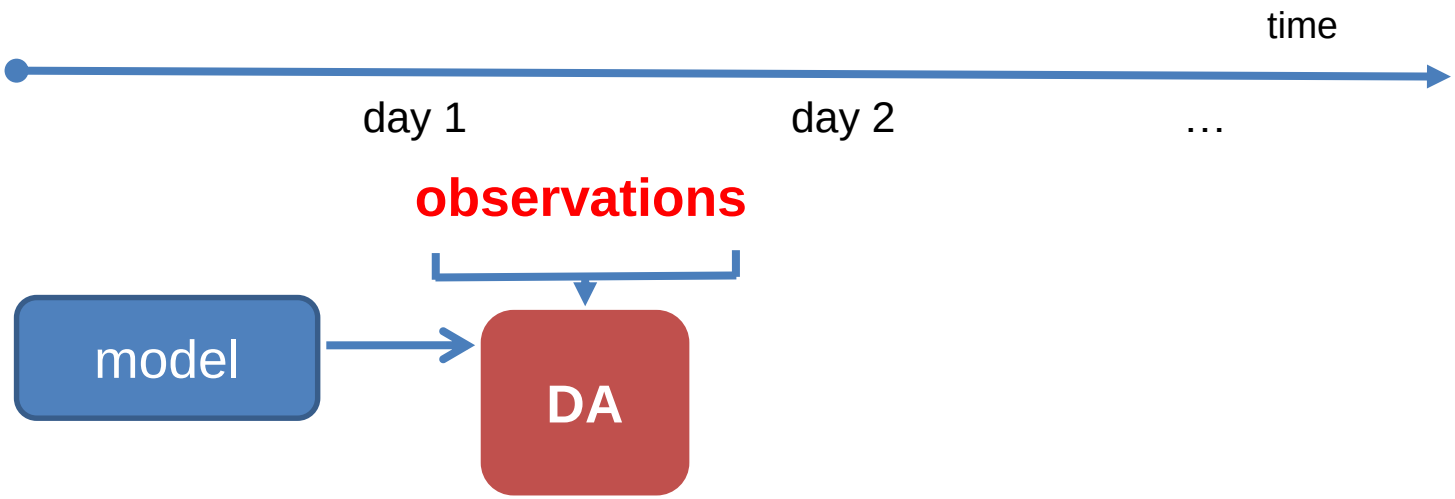


Data Assimilation Flow



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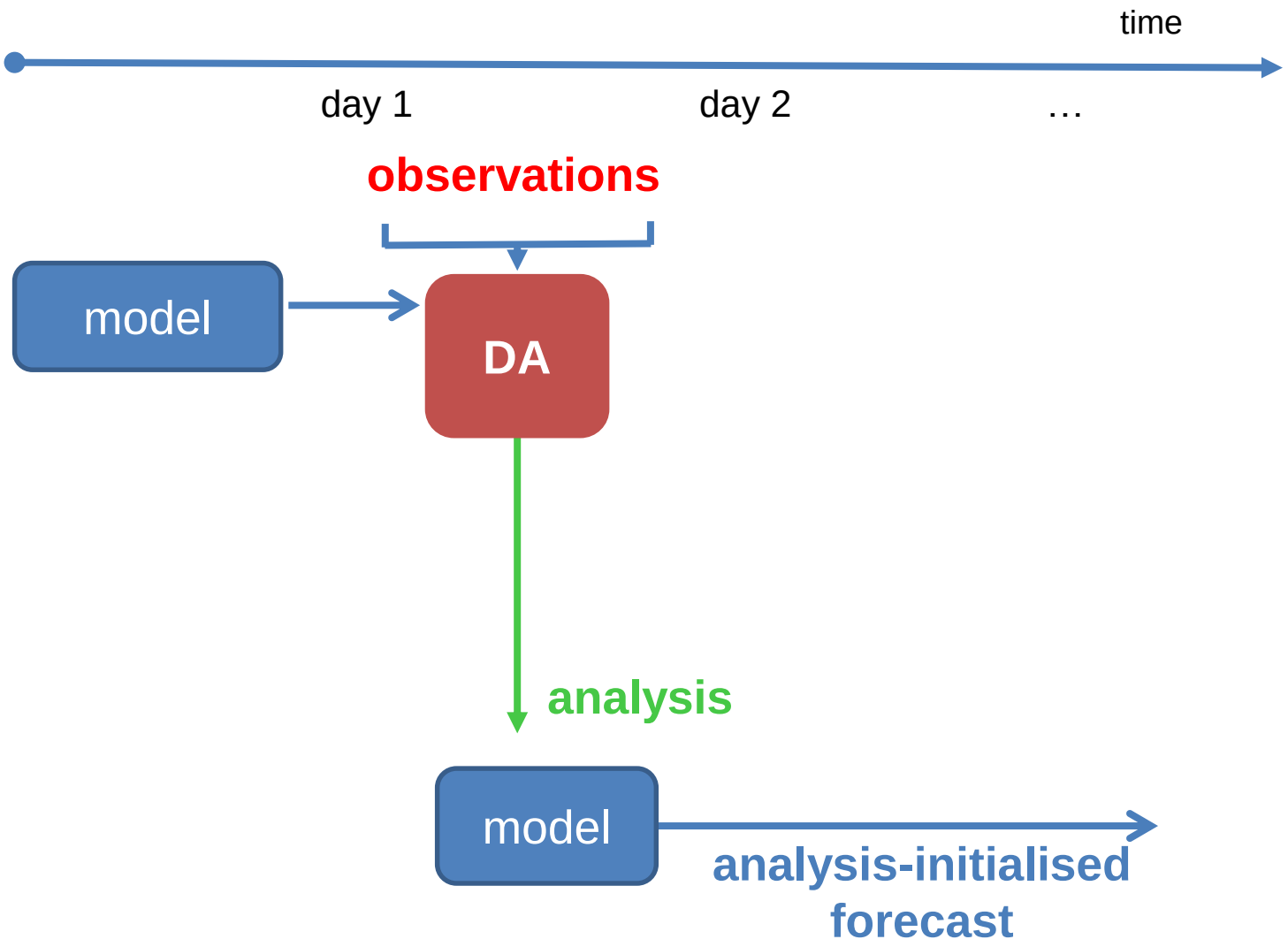

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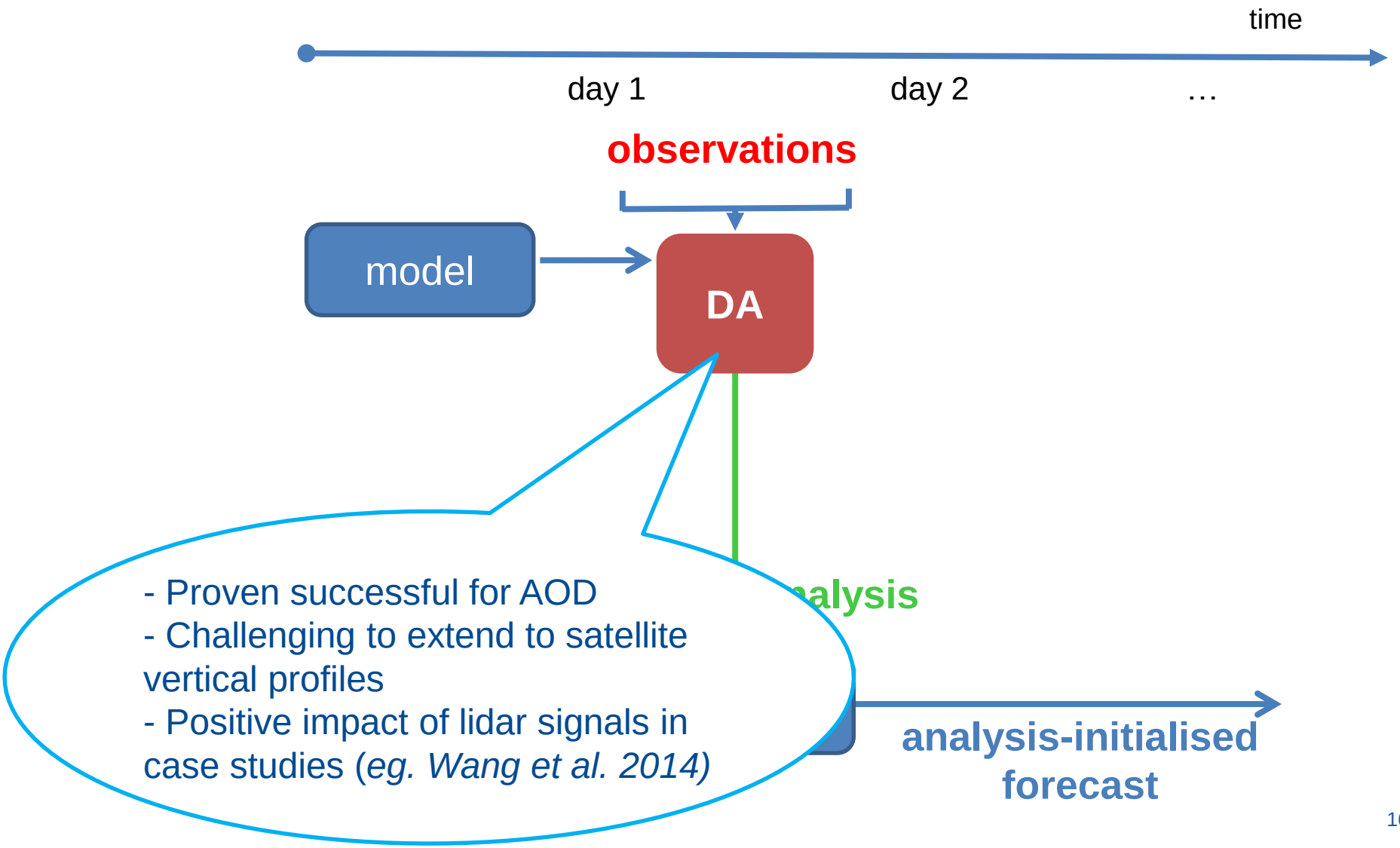
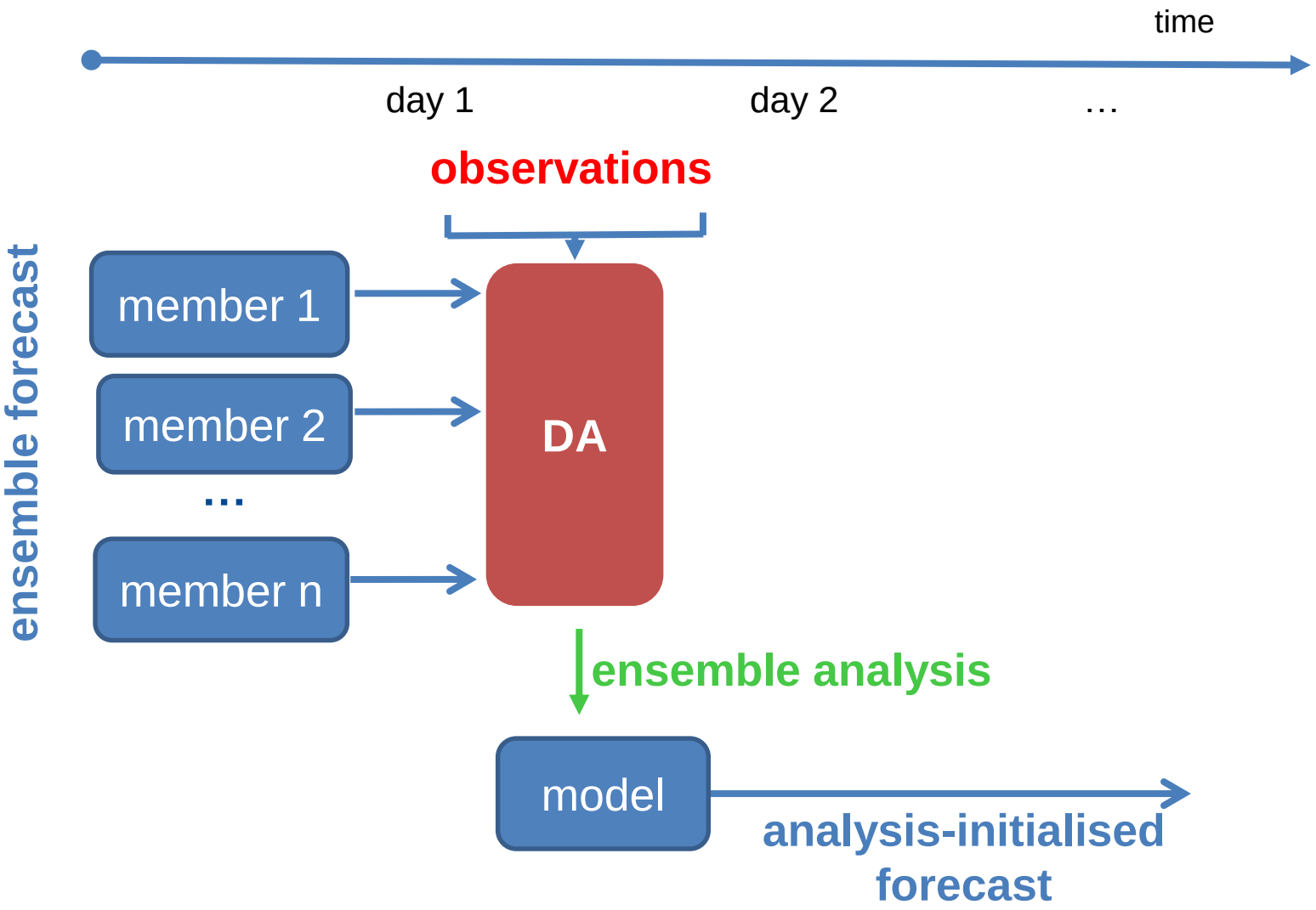


Ensemble-Based Approach



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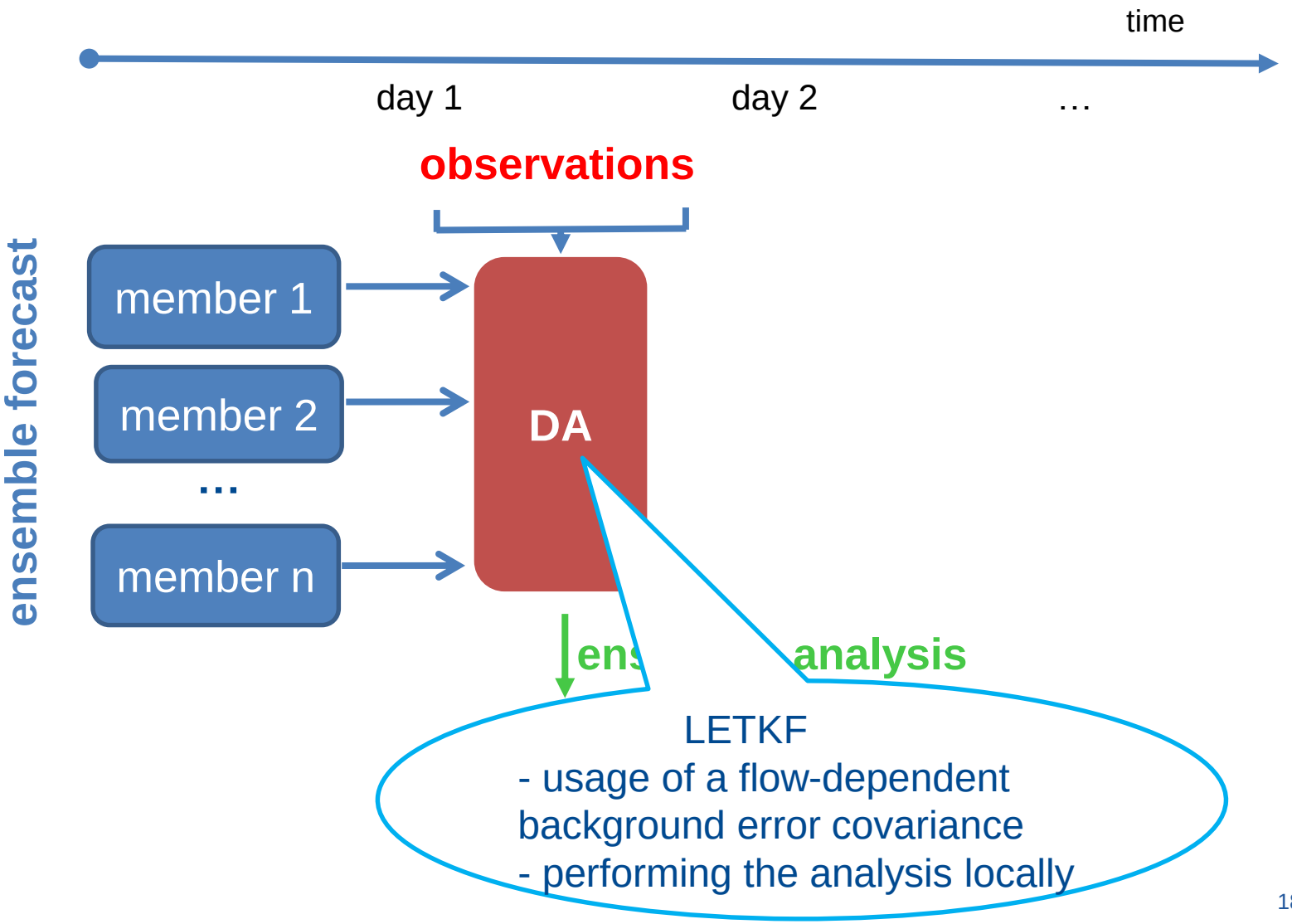

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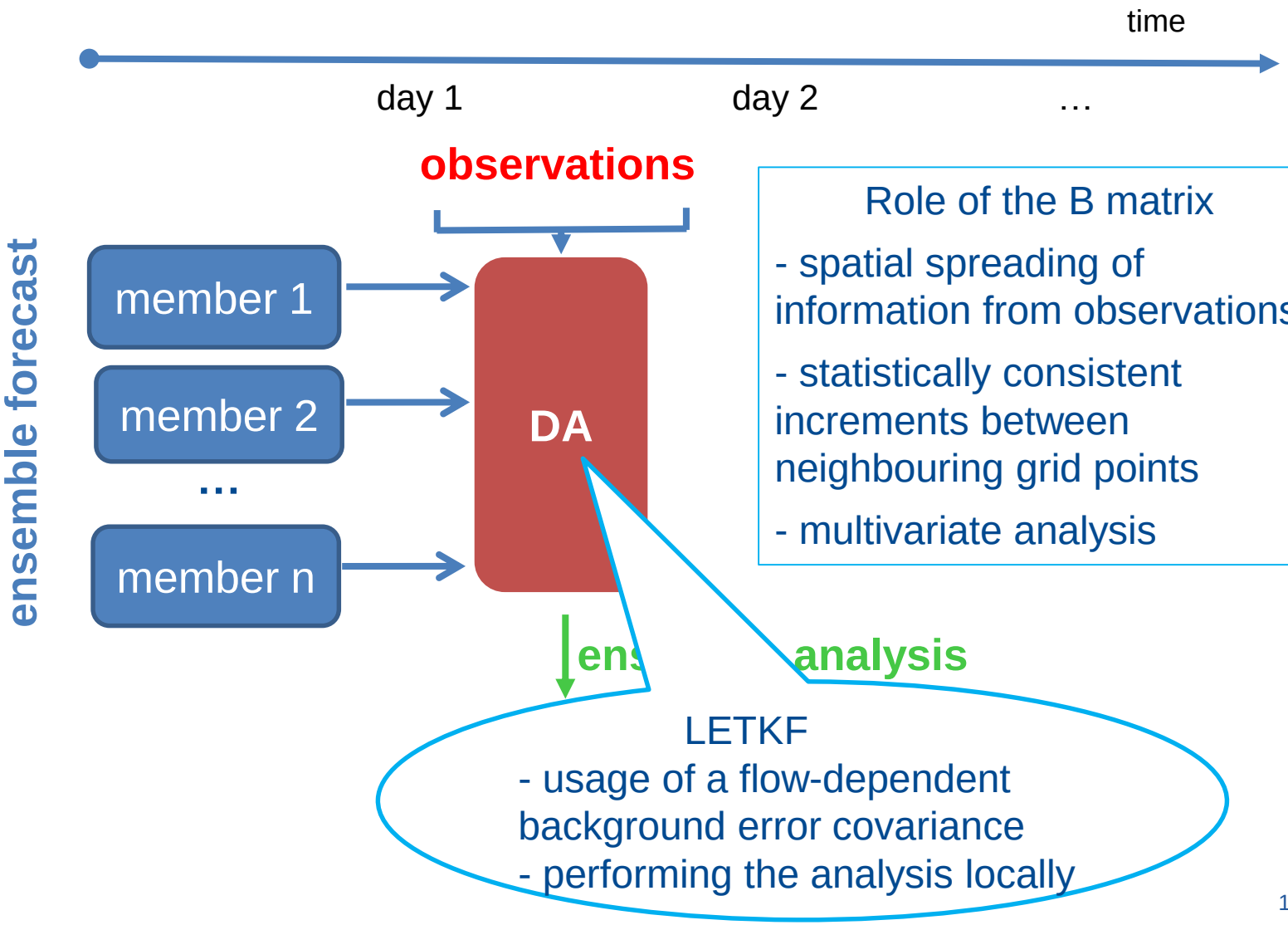
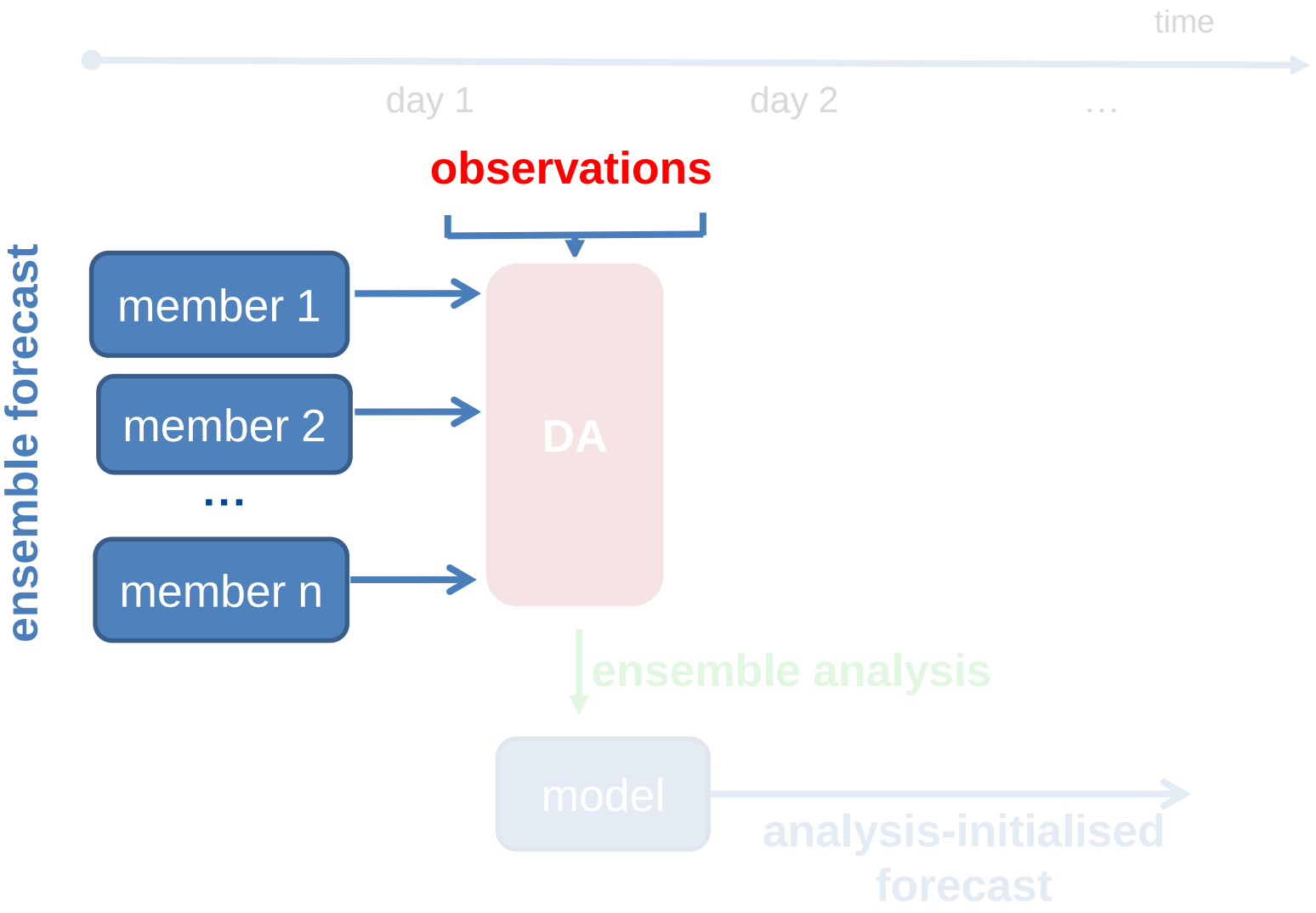


Role of the B matrix

- spatial spreading of information from observations
- statistically consistent increments between neighbouring grid points
- multivariate analysis

Ensemble-Based Approach



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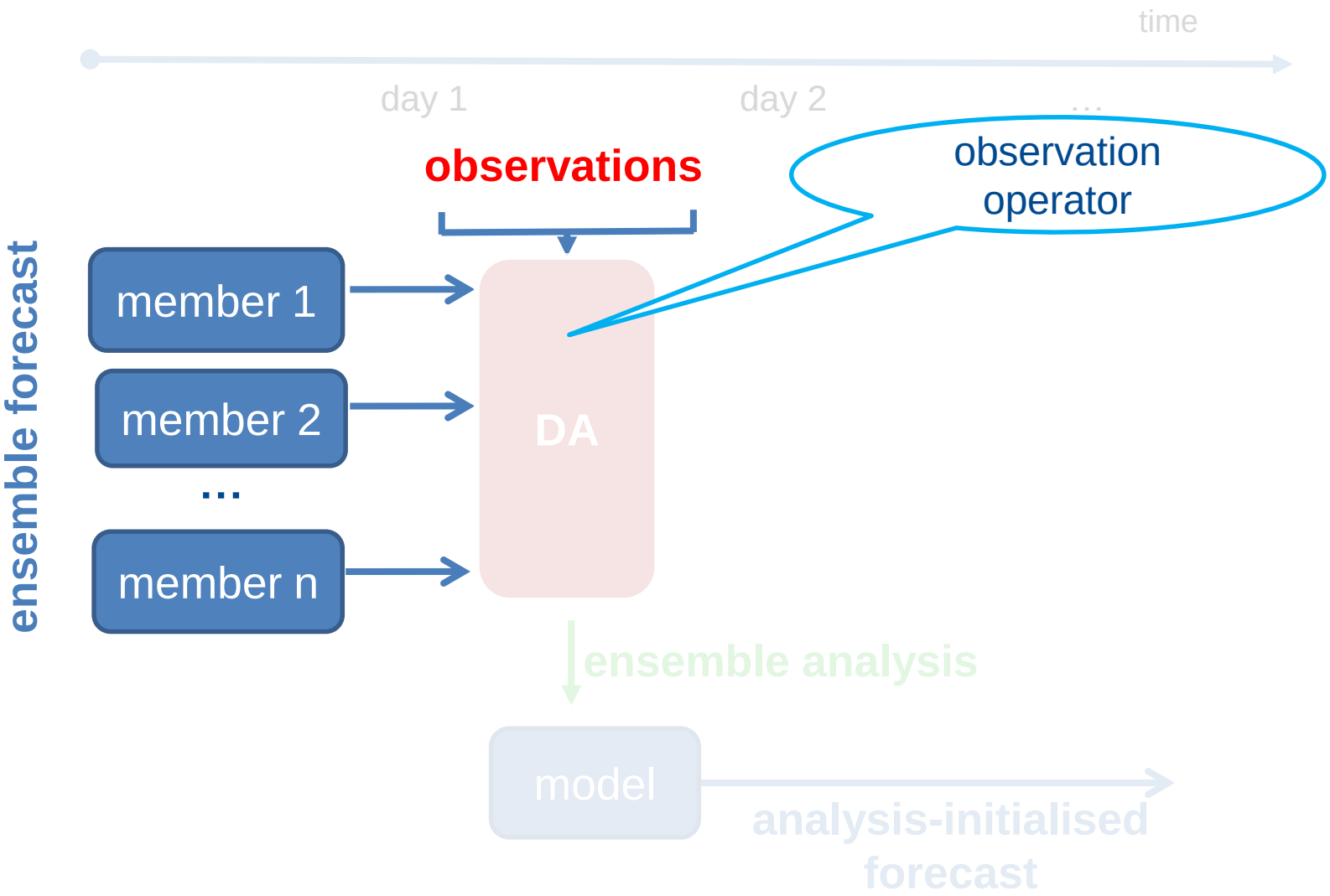

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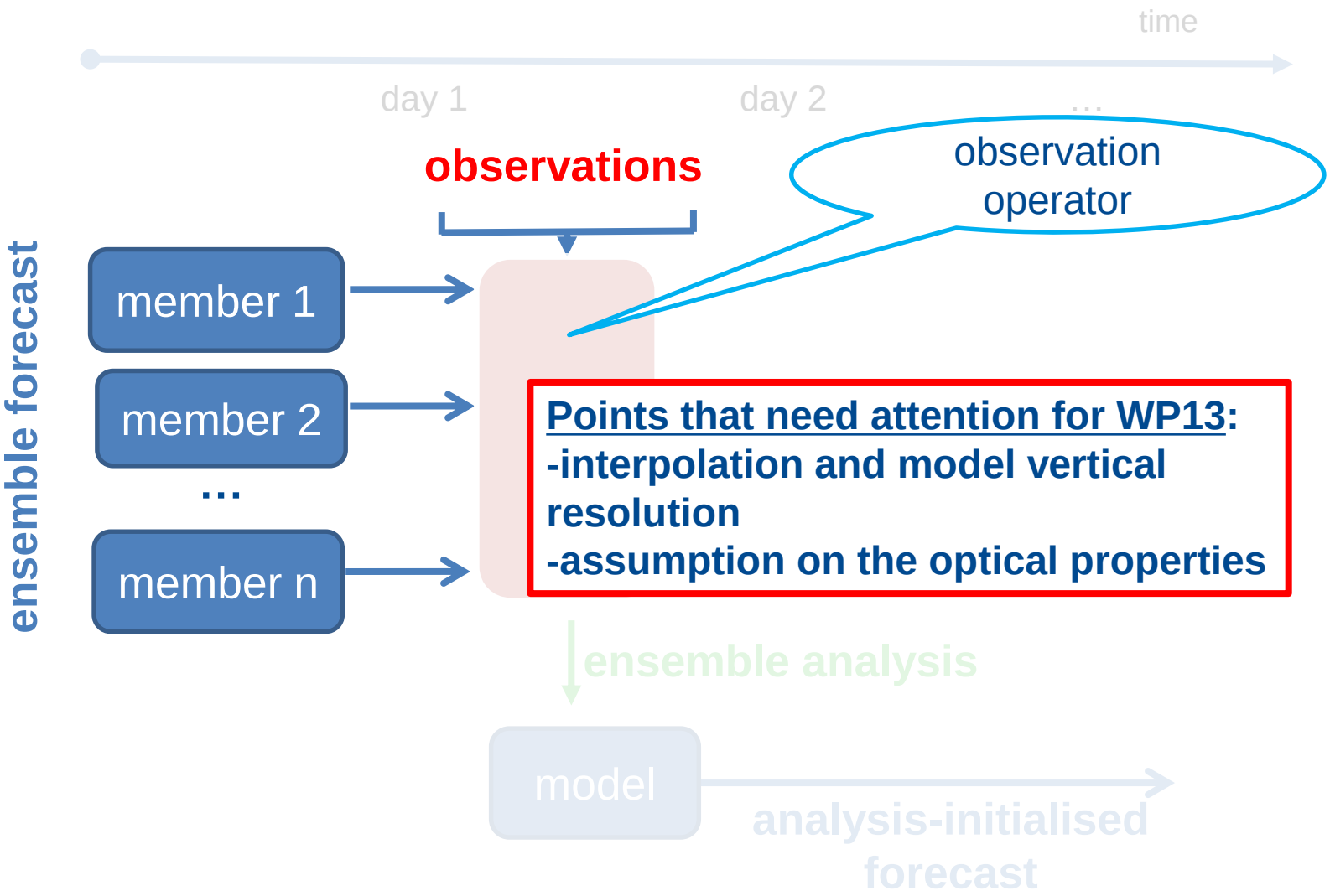

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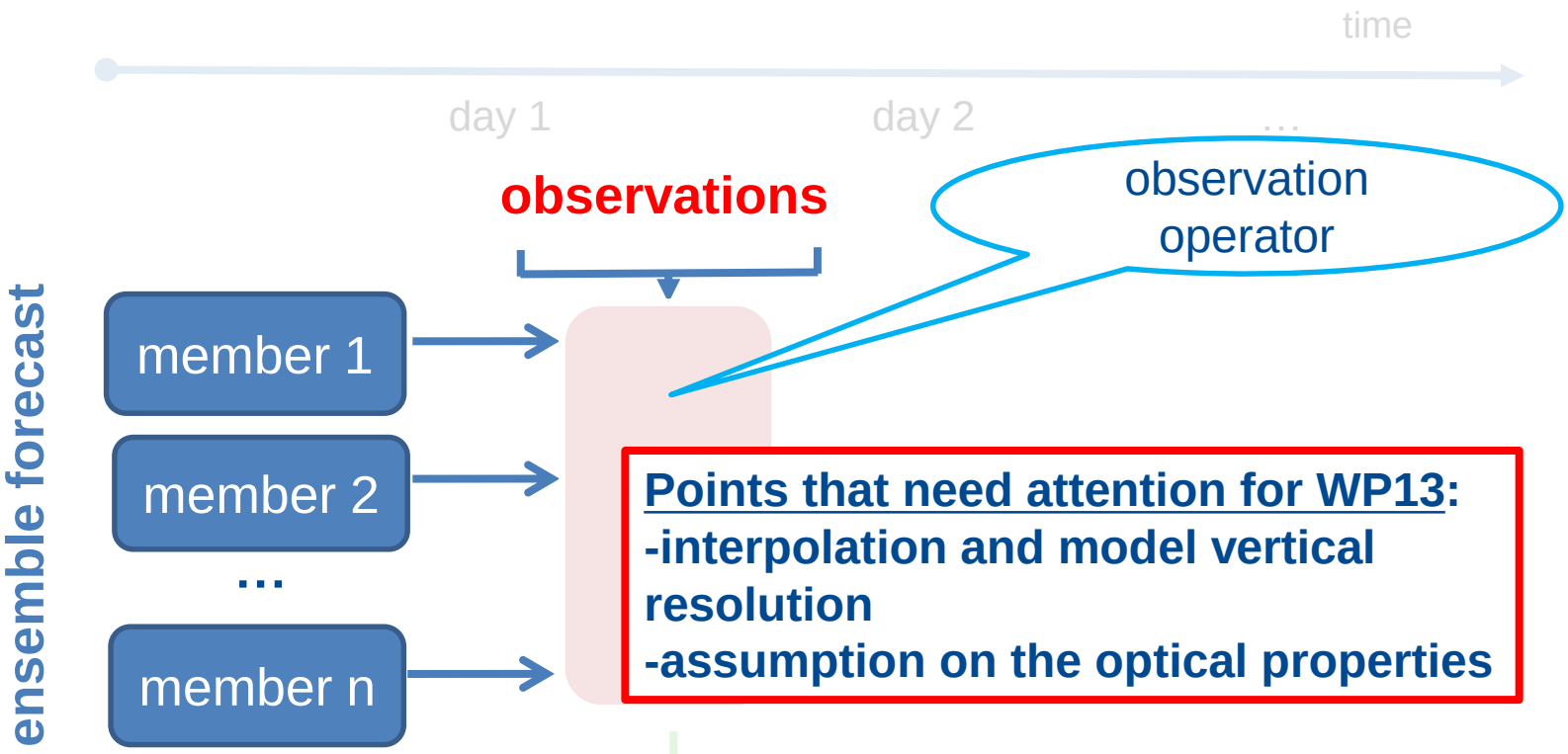
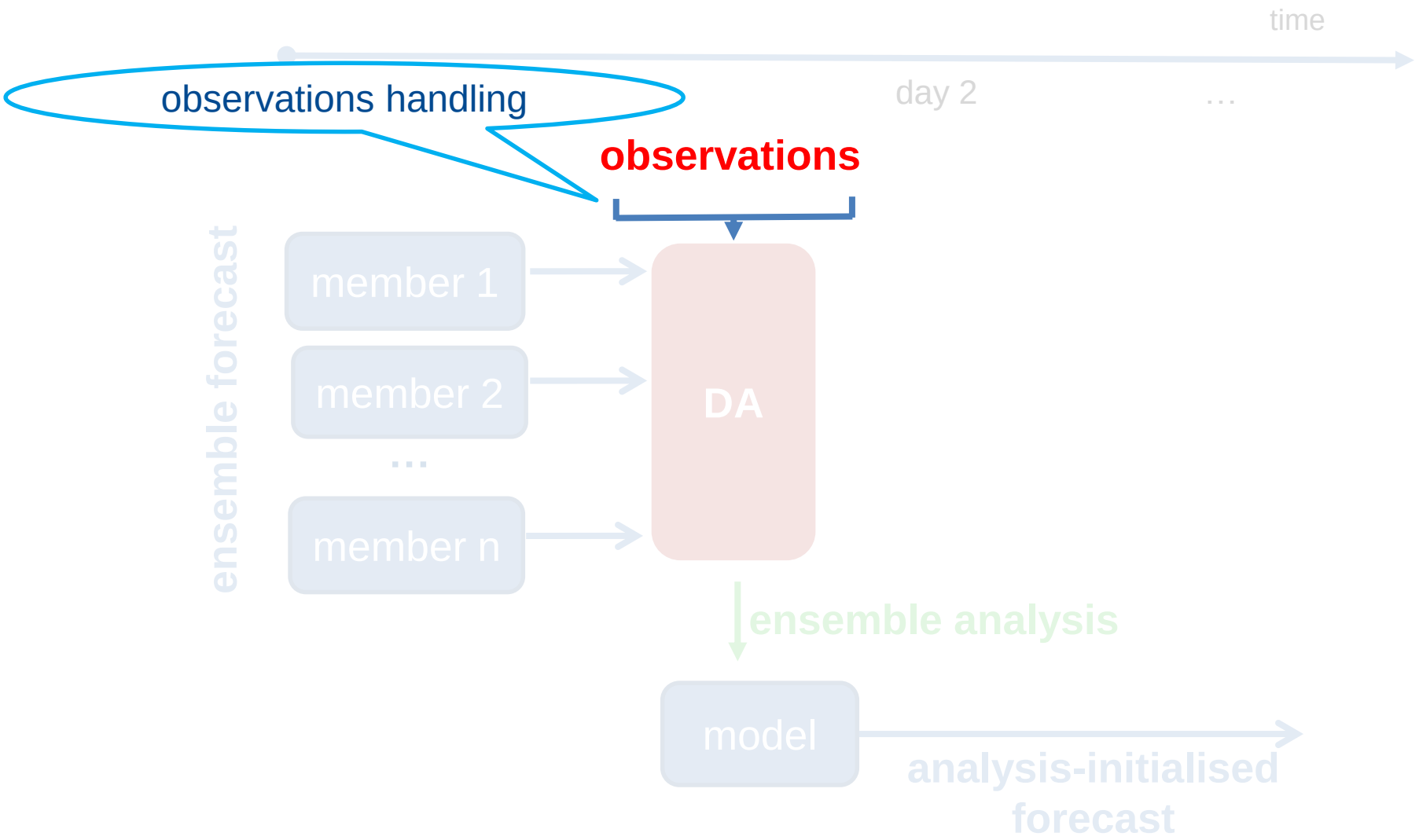


Observation operator for AOD

$$AOD_{\lambda} = \sum_z \sum_i C_{ext,i}(\lambda) c_{z,i} \Delta z$$

$c_{z,i}$	ensemble member mass concentrations for bin *i* [kg/m^3]
$C_{ext,i}(\lambda)$	mass extinction coefficients [m^2/kg]
Δz	layer thickness [m]

Ensemble-Based Approach



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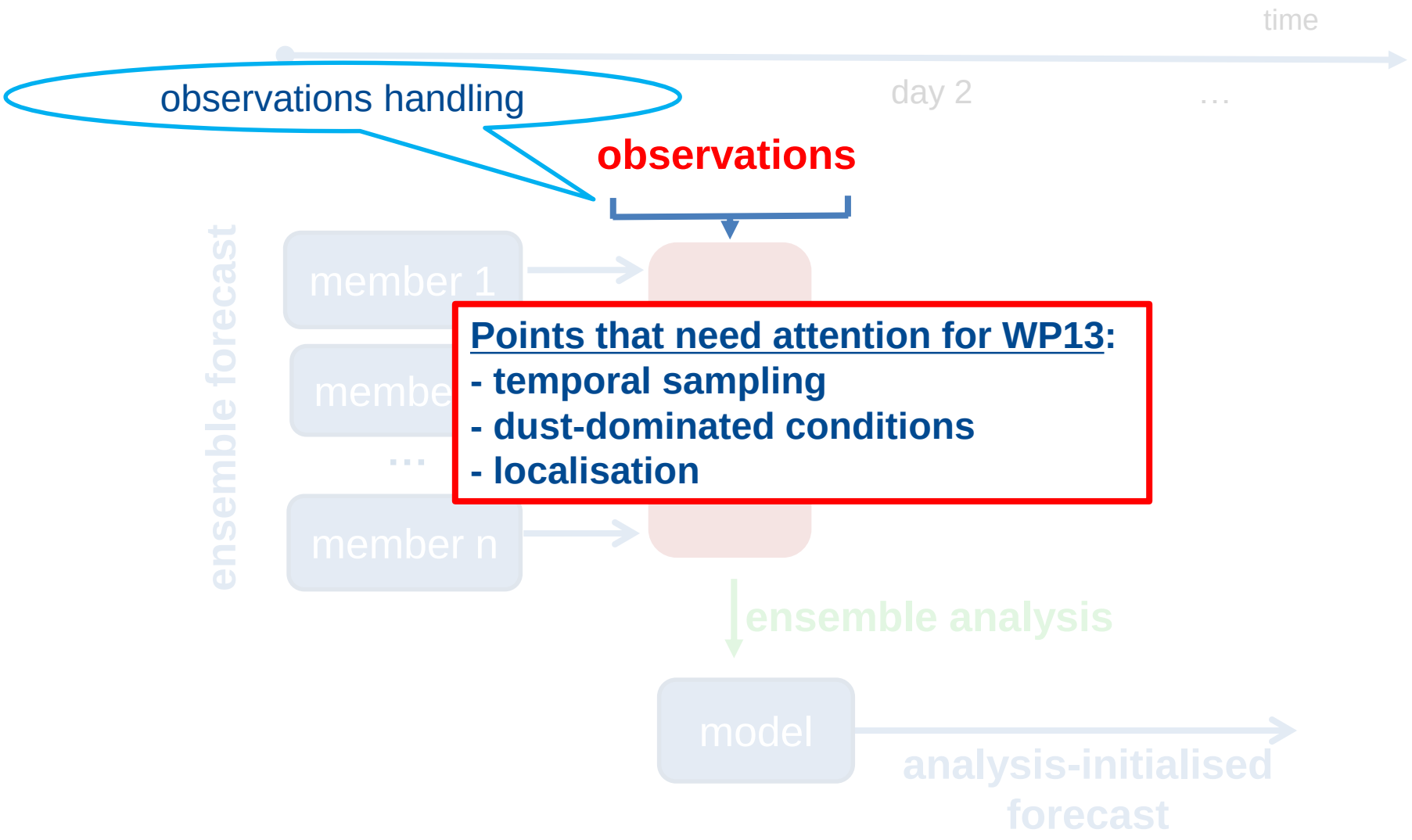

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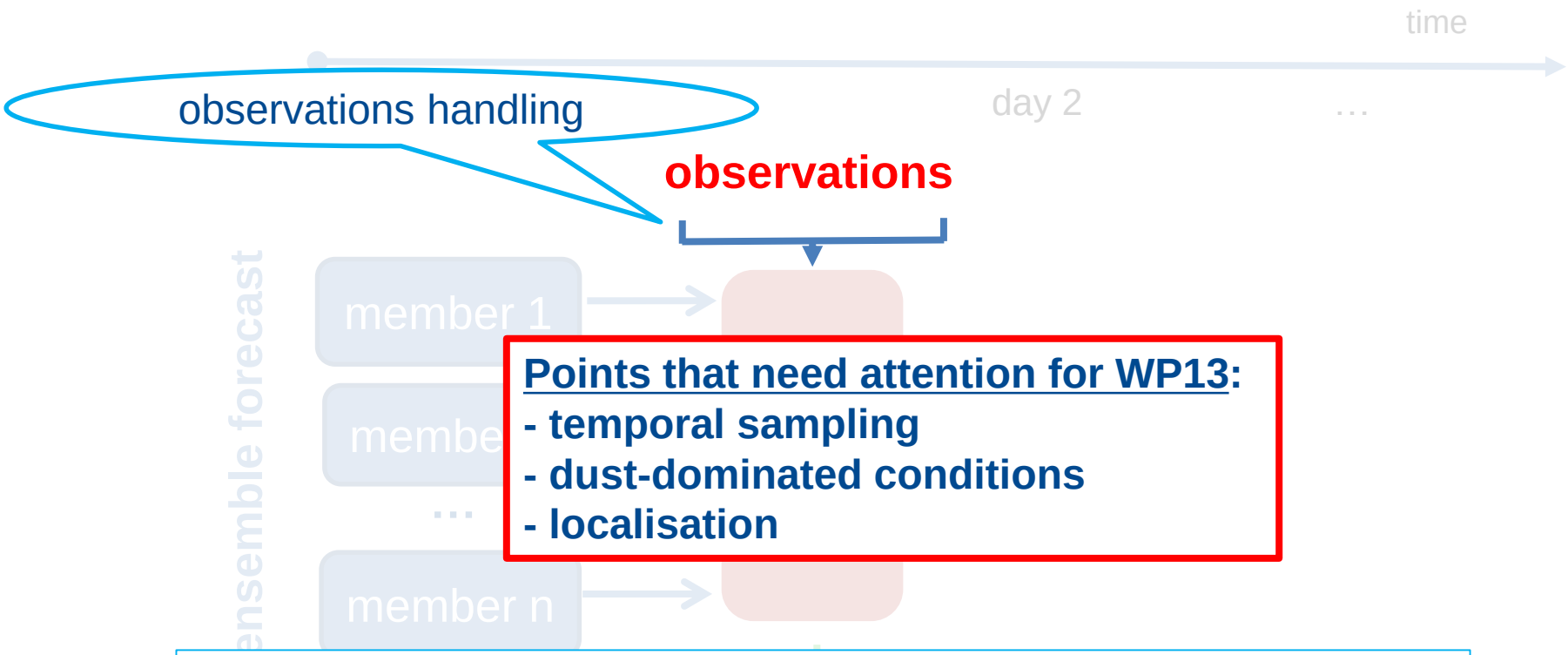


Points that need attention for WP13:
- **temporal sampling**
- **dust-dominated conditions**
- **localisation**

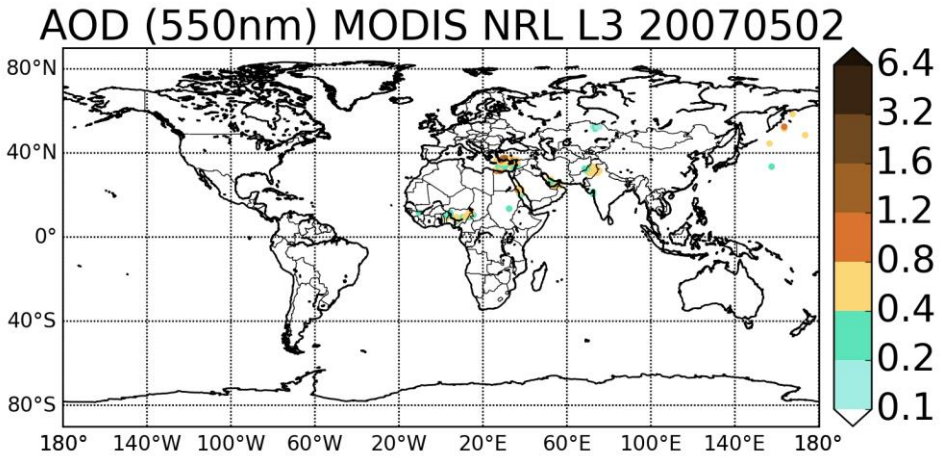
Observation-space localisation for AOD

- observation error is divided by a distance-dependent function that decays to zero with increasing distance (horizontal localisation)
- observation error is divided by the square of the model AOD normalised sensitivity function (vertical localisation)

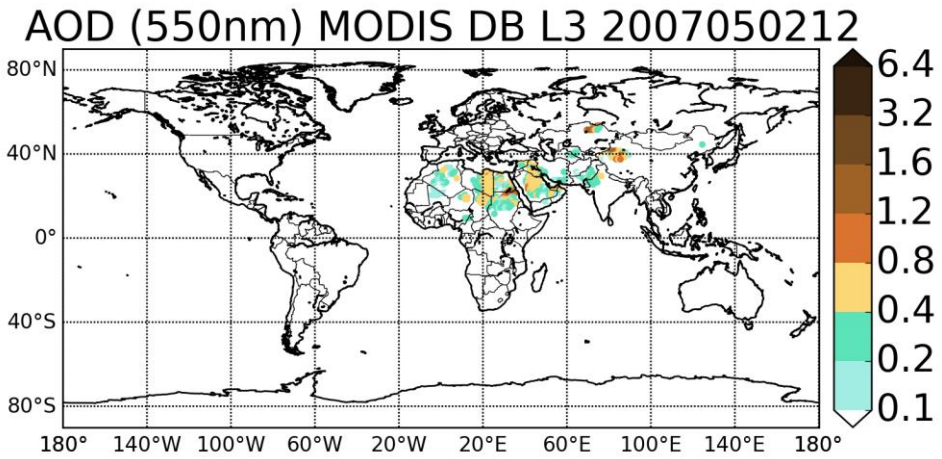
Satellite AOD Example

animation

Selected NRL MODIS observations



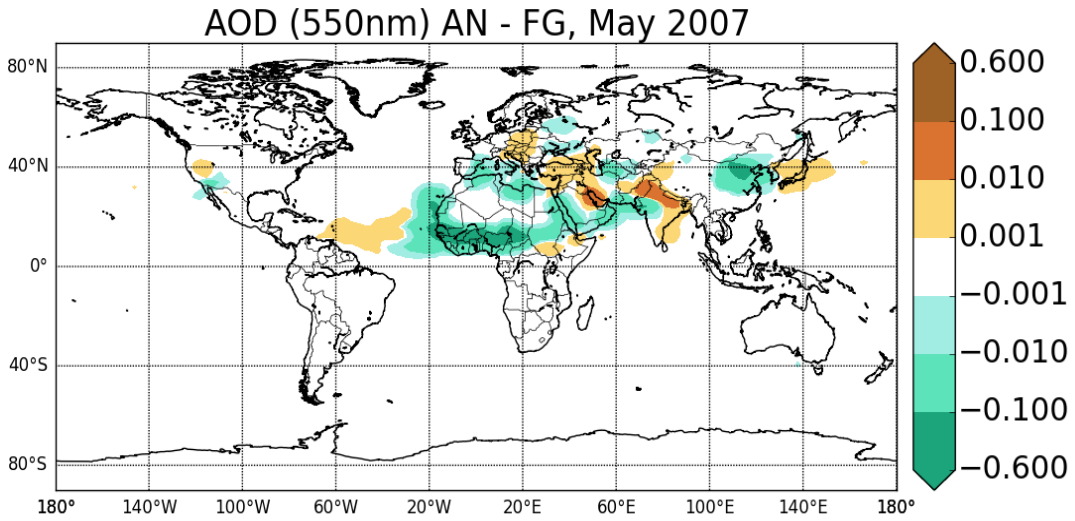
Selected MODIS DB observations



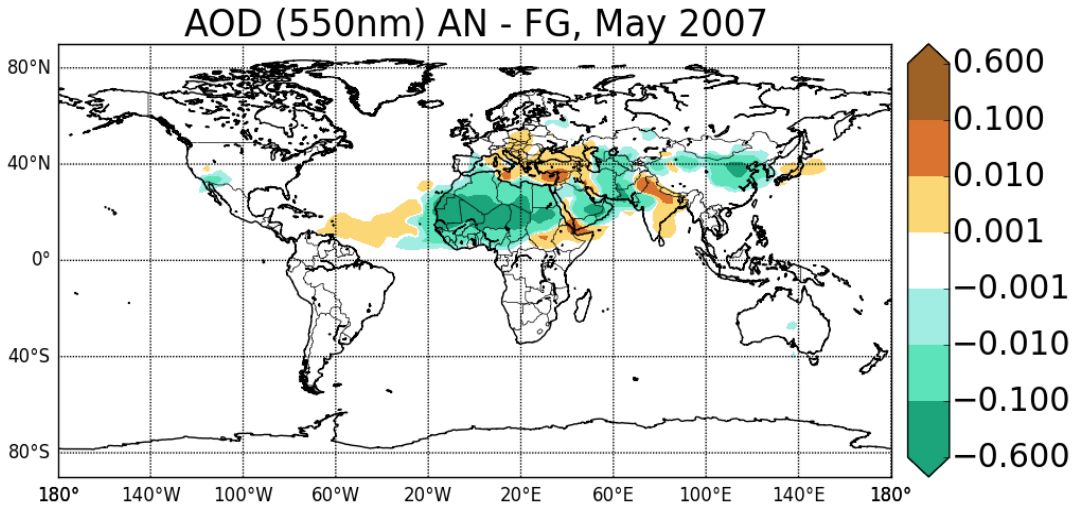
Satellite AOD Example

Mean increments

MODIS NRL



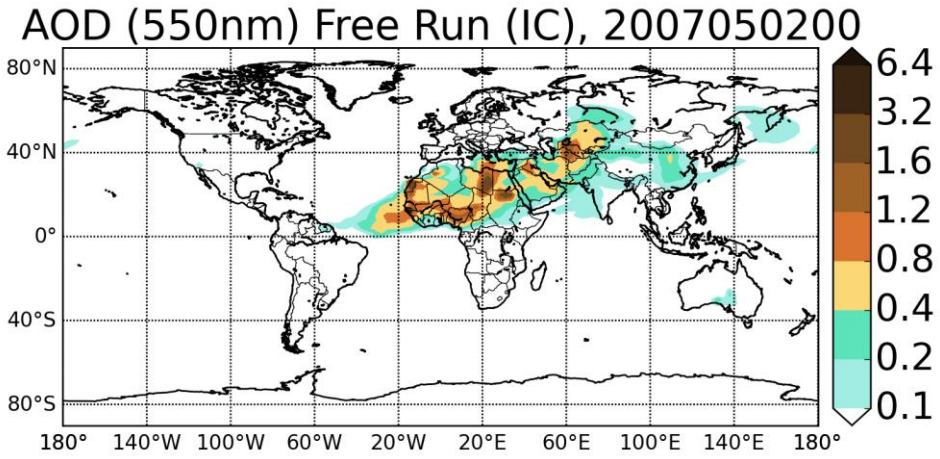
MODIS NRL +DB



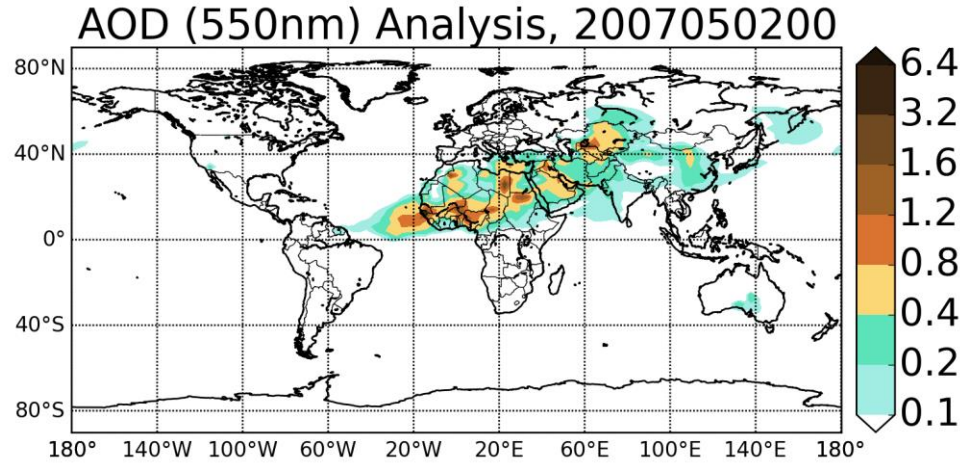
Satellite AOD Example

Control Simulation (No Assimilation)

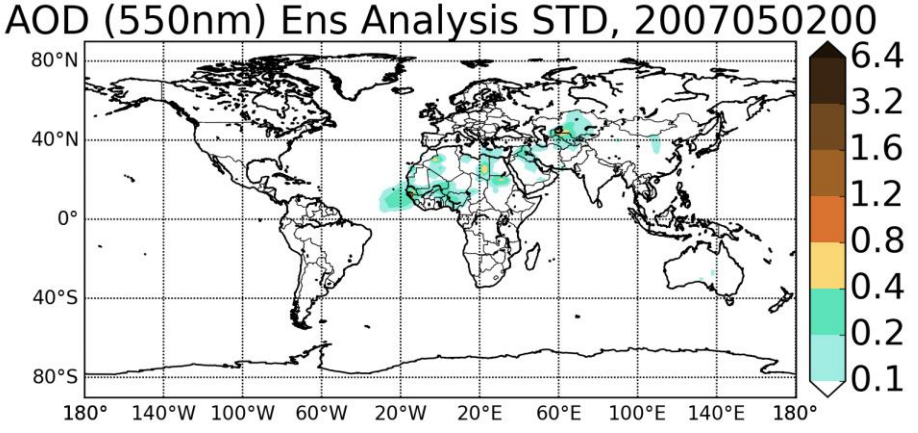
animation



Analysis



Analysis Spread



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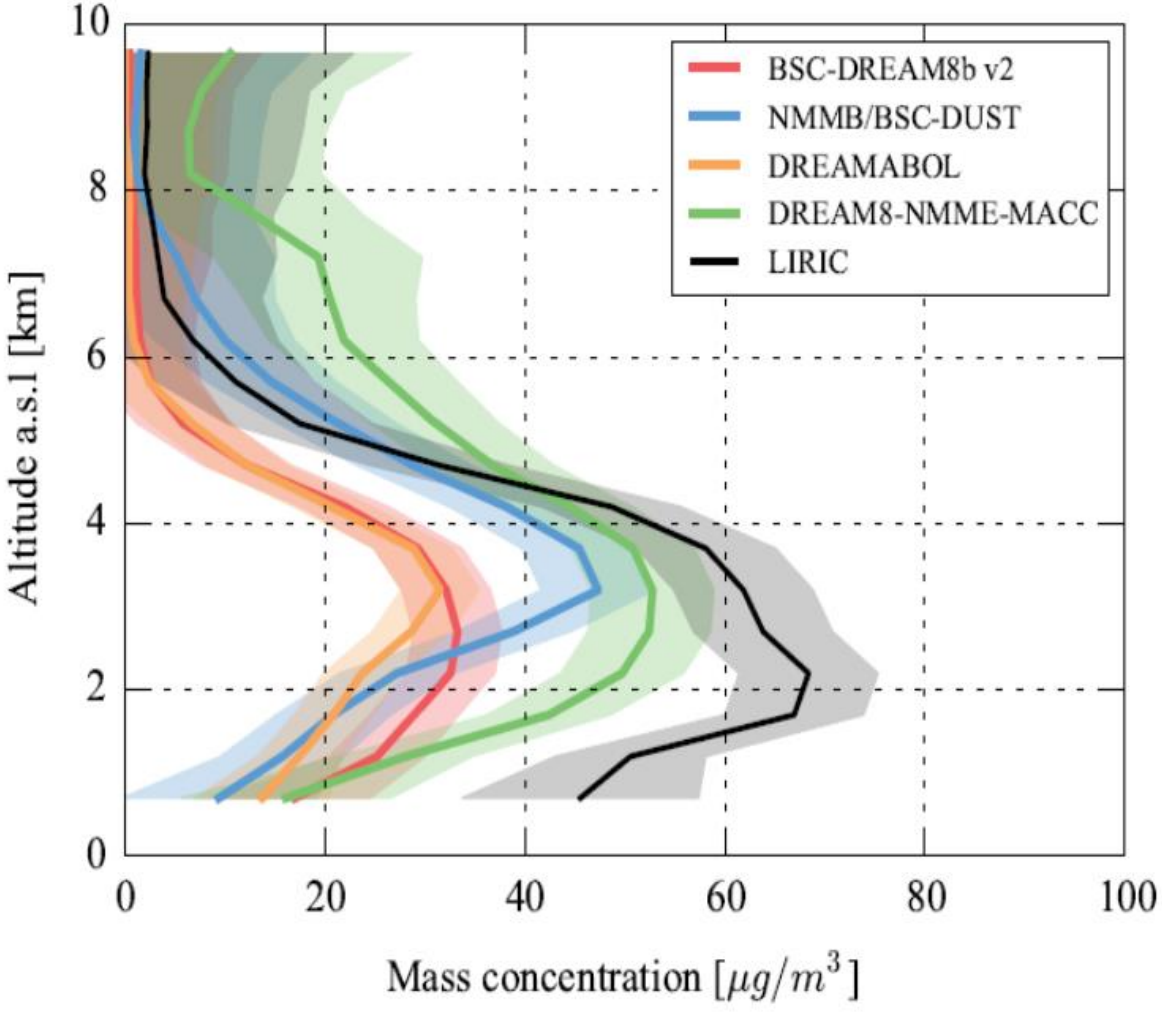
Thank you!

For further information please contact
enza.ditomaso@bsc.es

SDS-WAS: Model Intercomparison

EARLINET vertical profiles 2011-2013



(Binitieglou et al., 2015, AMT)

Slide courtesy of Sara Basart